# Should milk be a factor in a New Zealand asset pricing model?

**By**

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**A research exercise forming a part of the requirement for the degree of**

**Master of Commerce in Finance**

**At the**

**University of Canterbury**

**June 2016**

**Acknowledgements**

I would like to express my greater gratitude to my supervisor Dr. Alan Stent whose expertise, understanding, generous guidance, unwavering support, and mentorship made it possible for me to work on a topic that was of my keen interest. It was a pleasure working with him.

I am very grateful to my family for the encouragement which helped me in the completion of this paper. My beloved and supportive wife Marria and my lovely children Dannie and Nadia Eva, who serves as my inspiration to pursue this undertaking, without you, none of this would indeed be possible.

My appreciation and thanks also go to my lecturers, colleague, friends and people who have willingly helped me out with their abilities.

## Abstract

In New Zealand, Milk plays a significant role in determining the economic progress of the country. Since its incorporation in 2001 Fonterra has been the leading dairy company. It currently accounts for 95% exports of milk produced in New Zealand. Fonterra is a cooperative, and its stock can only be held by and traded among its farmer members. For this reason, the fluctuation in milk prices has a strong direct impact on farmers' incomes, but just an indirect impact on the incomes of outside (non-farmer) investors. The Fonterra Shareholder Market is a private market and is not included in the NZX50. The aim of this project is to explore whether milk price is an additional factor that investors are exposed to in additional to other market risks that are measured by the NZX50. An augmented market model is used to explore the sensitivity between company return, the NZX50, and milk prices. A cointegration test is also conducted to examine the relationship between market return and milk return. The project finds some evidence that there was a milk price effect in the period before 2013 when the Fonterra Shareholders' Fund was created. The Fonterra Shareholders' Fund provides exposure to milk price risk on the NZX. The effect is a small adjustment to the usual CAPM beta. There is no evidence of the effect after 2013.

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## Abbreviations

| | |
|---|---|
| **APT** | **Arbitrage Pricing Theory** |
| **ADF** | **Augmented Dickey-Fuller Test** |
| **CAPM** | **Capital Asset Pricing Model** |
| **FSF** | **Fonterra Shareholder Fund** |
| **FSM** | **Fonterra Shareholder Market** |
| **NSD** | **New Zealand Dollar** |
| **NZX** | **New Zealand Main Board** |
| **RVP** | **Register Volume Provider** |
| **TAF** | **Trading Among Farmers** |
| **USD** | **United States Dollar** |

# Chapter One:

# Introduction

# 1. Introduction

## *1.1 Overview*

The dairy industry is an important component of the New Zealand economy. It is a leading export earner and sells 95% of its products into the world market. A central component of the New Zealand dairy industry is the Fonterra Co-operative Group Limited (Fonterra). Fonterra was formed in 2001 from a merger of the two largest co-operatives at that time: the New Zealand Dairy Group and the Kiwi Co-operative. Fonterra currently accounts for 95% of exports of milk produced in New Zealand. Fonterra is owned and controlled by around 14,500 New Zealand co-op dairy farmer members that use its services and share equally the earnings of the business. To be a Fonterra shareholder, farmers have to supply milk to the company in New Zealand.

Before 2013 there was no direct way for the public to invest in Fonterra. Fluctuations in milk prices will have had a strong direct impact on farmers' incomes, but this risk could not be easily diluted on the financial market. Non-farmer investors could not include the exposure to dairy prices directly in their portfolios.

The situation changed in 2013 when Fonterra created a new class of shares. There are now two types: The Fonterra Shareholders' Market (FSM) and The Fonterra Shareholders' Fund (FSF). The Fonterra Shareholders' Market (FSM) is a private market. Only Fonterra, Fonterra Farmer Shareholders, and an appointed market maker are allowed to trade Fonterra Shares. Shares can only be held by and traded among its farmer members. However, farmer members can now deposit shares in the Fonterra Shareholders' Fund. Units of the fund are listed on the New Zealand and Australia stock exchanges. They can be purchased and traded by members of the public.

This raises questions for asset pricing models and motivates the present study. Asset models are usually derived under assumptions of competitive and liquid markets. For instance, the Capital Asset Pricing Model (CAPM) is a single factor model. Should milk price be an additional risk factor in the period prior to 2013? Is the situation different now?

### *1.2 Research Questions*

This study uses the framework of the Capital Asset Pricing Model to investigate milk price risk in the context of the New Zealand dairy industry, with co-operative farmers who have a non-marketable investment risk. It also explores the effects of milk prices on asset prices over the period 2005 to 2016. Specific questions are:

1. What are the characteristics that would make the risk of an asset greater or lower in the presence of milk price risk?
2. Does milk price risk have an observable price in New Zealand, or is it completely diversified?
3. Is there evidence of a milk price effect on assets in New Zealand?
4. Is there evidence of a change in the effect of milk price risk following the change to Fonterra's capital structure in 2013?

### *1.3 To whom will this study be of interest?*

This study will be of interest to students of the Capital Asset Pricing Model and its extensions. The CAPM has known shortcomings and many effects additional to market risk have been documented in the literature. This study investigates a milk price effect that can be associated with a particular market imperfection.

The study will also be of interest to financial analysts when forming investors' portfolios and calculating the cost of capital for publicly listed companies. Financial analysts need to understand the effects of this market imperfection even if it is small, and whether it is ongoing.

This research will also be an interest to other countries that might have similar market imperfections. For instance, cooperatives include the Arla Cooperatives in the European Union, Friesland Campina Cooperative in the Netherlands, Foremost Farms Cooperative in the U.S, Began Cooperative in Australia and Amul Cooperative in India.

### *1.4 Dissertation structure*

The organisation of this dissertation is as follows. Chapter 2 is a literature review. Chapter 3 examines the role of Milk and of Fonterra in the New Zealand economy. Chapter 4 presents the methodology used in the study. Chapter 5 outlines the data. Chapter 6 presents the results. Chapter 7 concludes.

# Chapter Two:

# Literature Review

## 2. Literature Review

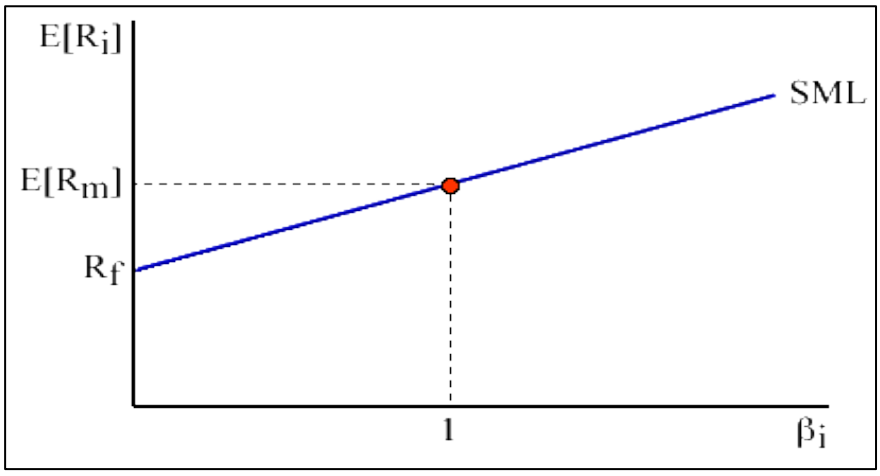
### *2.1 Asset Models*

#### *2.1.1 Capital Asset pricing model*

The Capital Asset pricing model (CAPM) was developed simultaneously by William Sharpe (1964) and Treynor (1961), and was developed further by Mossin (1966), John Linter (1965) and Black (1972). It argues that the expected return on a security depends only on the sensitivity of its return to the market return. It is a single factor model where the stock return is explained solely by the market return. Specifically, expected return on a stock is determined by the risk-free rate of return, the stock's beta, and the expected market return.

Essentially, it states an asset is expected to earn a risk-free rate of return plus a compensation for bearing risk. Figure 1 describes the relationship between beta and expected return, and it is the Security Market Line.

Figure 1: Relationship between beta and expected return



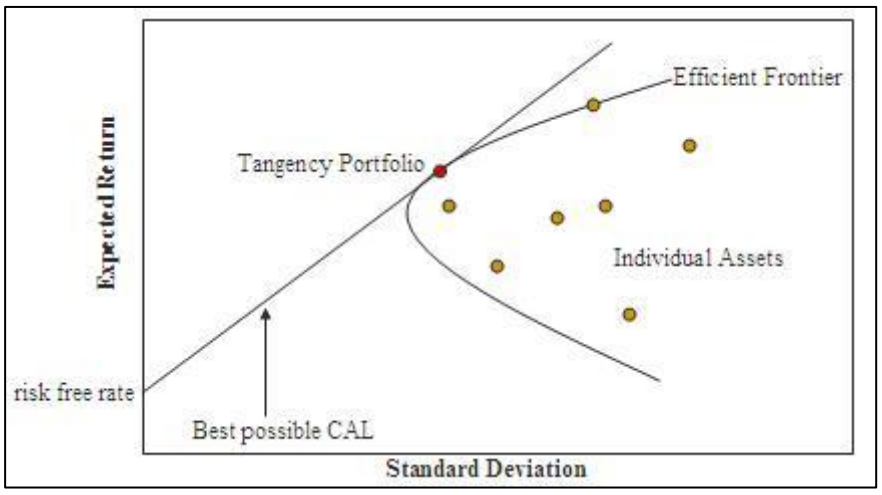

Source: Business Finance Online

CAPM can be used to evaluate active fund manager performance as it builds on the model of portfolio choice developed by Harry Markowiz (1959). It assumes that the risk-return profile of a portfolio can be optimised i.e. an optimal portfolio displays the lowest possible level of risk for its level of return. It is the set of portfolios each with the

feature that no other portfolio exists with a higher expected return but with the same standard deviation of return. The optimal portfolio must comprise every asset, with each asset value-weighted to achieve the above. All such optimal portfolios, i.e., one for each level of return, comprise the efficient frontier.

Because remaining risk, which is unsystematic risk is diversifiable, the total risk of a portfolio which the market will price, can be measured as beta. Figure 2 describes the portfolio opportunities and the CAPM model. The diagram is taken from the Wikipedia website.

Figure 2: Portfolio opportunities and the CAPM model




Criticism of the CAPM has emerged over time and the empirical record is poor. There is evidence that market return alone is not sufficient to describe expected return, and there are other variables. A list follows.

**Market capitalization** by Banz (1981). He finds that the shares of firms with large market capitalization have lower average return than low market capitalization stock and large firms tend to have lower return even after controlling Earning /Price ratio.

**Leverage** by Bhandari (1988). He included leverage as a function of average return as high leverage will increase the riskiness of firm equity and beta coefficient.

**The book-to-market** ratio by Chan, Hamao and Lakonishok (1991). They find that book to market equity has a direct impact on the relationship with expected return.

**Winner/Loser stock** by DeBondt and Thaler (1985). They find that stocks that had a good return over the past three to five years have much lower average returns than 'losers' over the next three to five years.

**Momentum** by Jegadeesh (1990, 1993) and Titman (1993). They find that stock return exhibits a short-term momentum, and momentum is strong for firms with poor recent performance.

There is a study on CAPM anomalies in New Zealand by Gillan (1990). Gillian investigates the price-earning (P/E) ratio and small firm effects on the New Zealand Stock Exchange (NZSE). He applies the method developed by Banz (1981) and Reinganum (1981), to 200 securities on the NZSE over the period of 1977 to 1984. He found evidence for a small firm effect, but not for a P/E effect on the NZSE.

### *2.1.2 Three factor model*

In contrast with the CAPM that uses only one variable to explain return on stocks, Fama and French (1992) propose a model which controls size and book-to-market ratio as well as beta. They used three variables to describe the return on stocks. It starts with the observation that two classes of stocks do better than the market, i.e. Small Caps stock and stocks with a low Price-to-Book ratios, and then adds these two factors to the CAPM. This three factor model explains portfolios of returns better than the one factor CAPM.

The new factors are calculated with combinations of portfolios composed by ranking stocks available from historical market data. In summary, the Fama-French three-factor model viewed both size and value as risk factors, for which one is rewarded with extra return.

### *2.1.3 Arbitrage Pricing theory*

The Arbitrage Pricing Theory (APT) was developed by Ross (1976). It offers a testable alternative to the CAPM. It hypothesises that stock return is affected by a range of exogenous variables. It is influenced by systematic risk in the economy which affects all stocks to some degree. APT includes multiple factors that represent the fundamental risks in asset return and thus the prices of securities.

The APT is derived under the usual assumption of a perfectly competitive and frictionless capital market. In equilibrium all portfolios that can be selected from among the set of assets under consideration and that satisfy the condition of using no wealth and having no risk, must earn no return on average. These portfolios are called arbitrage portfolios.

Kazi M.H. (2008) applied APT on six *a priori* proxy variables to identify the systematic risk factors for the Australian stock market. Initially, 15 relevant macro-variables were considered to be the proxy. Through a variable selection process, the initial fifteen variables were reduced to six. Although not all variables are significantly influential, the linear combination of these six variables is observed to be cointegrated. He found that in the long-run 5 variables: bank interest rate, dividend yield, corporate profitability, industrial production and global market movements significantly influence the Australia stock market returns, but in the short-run it will be affected by only 3 variables: its own performance, interest rates and global stock market movements.

## ***2.2 Economic factors***

An effect on asset prices might be present in an economy with a dominant resource, such as oil or a commodity. Oil is a common example.

### *2.2.1 Oil effect*

Over recent years, the impact and role of oil on stock prices and the financial market have been studied, among other variables, by a number of researchers. Bopp & Lady (1991), Farmer (1993), Moosa & Al-Loughani (1994), and Foster (1996), have analysed how forward and future prices effect oil related contracts. Strong (1991) examined how investors use oil equity portfolios to hedge the risk of oil price. Chen, Roll and Ross (1986), Hamao (1989), Al-Mudhaf and Goodwin (1993), Kaneko and Lee (1995), and Jones and Kaul (1996) investigated whether oil price has an influence in determining the price of equities in U.S, Canada, Japan and U.K markets.

Chen *et al.* implemented a multi-factor asset pricing model test using a macroeconomic set of variables and including the possibility that return series from oil prices could constitute an economic pricing factor. They found no evidence in a sample of U.S. equities to suggest that such a factor exists. Hamao applying the same approach as Chen *et al.* to the Japanese market, obtained a similar result.

However, Kaneko and Lee discovered that an oil price change factor is important in a recent sample of Japanese equity data. Jones and Kaul is a most comprehensive study on the impact of oil price changes in Canada, Japan, the U.K and U.S. They found that oil price changes have an unfavourable effect on output and real stock returns in all the four countries.

## ***2.3 Milk as an additional factor***

Milk is an important commodity in the New Zealand economy and is a possible additional economic factor for an asset pricing model. The role of Fonterra which is a co-operative owned by around 14,500 New Zealand dairy farmers, is also significant. Until 2003 when the Fonterra Shareholders' Fund was created, investors could not include the exposure to dairy prices directly in their portfolios. One of the assumptions of the CAPM model is that investments are publicly traded assets; i.e. all assets are perfectly marketable (liquid). The dairy assets of the New Zealand farmers were not liquid and not part of the investment set in the CAPM. Mayers (1972, 1973) treated the similar issue of personal capital. He extended the CAPM for the case where there are two kinds of assets: marketable (perfectly liquid) and nonmarketable (perfectly

nonliquid). The extended model shows that the linear form of the risk-expected return relationship is similar to the original CAPM model, but an asset's beta now depends on the covariance with non-marketable assets as well as with the market index. Fama and Schwert (1977) reviewed Mayers (1973) extended model and argued that the effect on the risk measure beta will be small for the case of human capital and not have important effects. However, the effect for a significant asset like milk might be different. This is an empirical issue which motivates the present study.

Many researchers have continuing interest in studying the role and impact of oil and other commodities on the financial market and stock prices. To my knowledge, there has been no research in studying the role of milk.

# Chapter Three:

# Milk, Fonterra and the New Zealand Economy

## 3. Milk, Fonterra and the New Zealand Economy

### *3.1 Introduction*

Since the early 1800s, the New Zealand dairy industry has gone from farmers keeping a few domestic cows in the bush to being a world leader (Hugh and Frank,2012). In 2009, the New Zealand dairy industry had export sales of more than NZD13.7 billion making it a leading export earner and selling 95% of its dairy products abroad, which is a greater proportion than any other country (Dairying Today,2015). As at 2015 New Zealand is one of the major exporters of whole milk powder (WMP) capturing almost 65% of the world market. (IndexMundi,2016).

The dairy industry has always played a significant role in the New Zealand economy. It had contributed an amount of NZD18.1 billion in 2014, being 25% of New Zealand export earnings. It has fed more than 100 million people worldwide. It represents approximately one-third of international dairy trade each year.

In New Zealand farmers receive no subsidies, which has encouraged a focus on low-cost, high productivity farming system. The dairy processing facilities in New Zealand are mostly co-operatively-owned by farmers, with the main co-operatives being Fonterra, Westland and Tatua.

### *3.2 Fonterra*

The first co-operative company in New Zealand was established in Otago in 1871, to benefit from the pooled resources. By 1930s most dairy factories in New Zealand were owned by co-operatives, and more than 400 begin selling their products overseas; however this became difficult, so in 1923 to control all dairy exports the New Zealand government established the Dairy Export Produce Control Board.

With the Dairy Board, farmers are able to access new markets and able to gain better returns for their production, and make the milk industry grow and prosper. As a result, to become more efficient, aided by improved technologies in transport and

refrigeration, co-operatives began joining forces. By the 1960s, a total of 400 co-operatives had merged to 168 co-operatives.

In the 1960s, the New Zealand Milk industry started to diversify their markets and product ranges. By the 1980s they had 19 overseas subsidiaries and associated companies. In 1995 it had increased to 80. The New Zealand Dairy Board become the world's largest dedicated dairy marketing network.

In 1996, the industry then consolidated further to only 12 dairy companies. When the Government transferred the Dairy Board's assets to them, the competing dairy co-operatives were forced to work together for the first time. By the end of 2000, two major companies - New Zealand Dairy Group and Kiwi Co-operative Dairies - represented more than 95 percent of the industry. Two smaller co-operatives, Westland and Tatua, held the remaining 5 per cent.

In 2001, the two largest co-operatives, New Zealand Dairy Group and Kiwi Co-operative, merged to form Fonterra. It is a leading multinational dairy company, owned by around 14,500 New Zealand dairy farmers and is responsible for approximately 30% of world dairy exports and it is the world's largest exporter of dairy products. The Fonterra Group's global supply chain stretches from Fonterra's shareholders' farms in New Zealand through to consumers in more than 100 countries and markets over 2 million tonnes of product annually. This makes the Fonterra Group the world's leader in large scale milk procurement, processing and management, with some of the world's best-known dairy brands including Anchor, Anlene and Anmum.

As a co-operative, Fonterra is owned and controlled by the co-op members that use its services and share equally the earnings of the business. In order to be Fonterra shareholders, farmers have to supply milk to the company in New Zealand. Fonterra shareholders hold one share for each kilogramme of milk solids they supply to the co-operative, with the exception of a limited number of shareholders supplying milk under contact arrangements.

There are two different types of shares at Fonterra, The Fonterra Shareholders' Market and The Fonterra Shareholders' Fund.

The Fonterra Shareholders' Market (FSM) is a private market. Only Fonterra, Fonterra farmer shareholders, and an appointed market maker (known as the Register Volume Provider or RVP) are allowed to trade Fonterra shares. The FSM forms part of Trading Among Farmers (TAF), Introduced in late 2012 where Farmer Shareholders can buy and sell Shares among themselves, not with Fonterra.

Before late 2012 farmers could buy and sell shares directly from Fonterra. Fonterra had to issue shares to farmer shareholders when milk production increased, and was obliged to take them back (or redeem them) if the farmer shareholder stopped supplying milk to Fonterra, or their milk production decreased.

Fonterra's obligation to redeem shares exposed it to the risk that it may have to pay large sums of money to farmer shareholders who stopped or reduced their supply of milk to Fonterra (redemption risk).

Trading Among Farmers is designed to remove this redemption risk for Fonterra, and provide Fonterra with a stable capital base.

### *3.2.1 Trading Among Farmers*

Trading Among Farmers has two functions.

Firstly, it is a series of inter-related arrangements that enable farmer shareholders to trade shares between themselves in the Fonterra Shareholders' Market, instead of Fonterra being required to issue and redeem shares,

Secondly, it enables outside investors, who are not allowed to hold shares in Fonterra, to invest in a security (a unit in the Fonterra Shareholders' Fund) that gives them access to the economic rights that they would have received if they were allowed to own a share.

#### *3.2.1.1 The Fonterra Shareholders' Fund (FSF*)

The fund is intended to supplement liquidity in the Fonterra Shareholders' Market through a liquid market for units which can be exchanged for shares in the FSM.

FSF is a unit trust formed under the Unit Trusts Act. It is managed by a Manager and has a Trustee. Units can be exchanged for shares of FSM (and vice versa) by Farmer Shareholders, Fonterra and the Registered Volume Provider on a one-for-one basis. Other investors cannot exchange units for shares in FSM. Units of FSF are listed on the NZX Main Board and on the ASX and can be freely bought and sold, in the same way as any other listed security.

#### *3.2.1.2 Fonterra Shareholders' Market (FSM)*

The Fonterra Shareholders' Market is operated by the NZX. It is regulated and monitored by NZX and the Financial Markets Authority, in the same way as other markets are operated by NZX. Farmer shareholders, Fonterra and the Register Volume Provider (RVP) can buy or sell shares in the Fonterra Shareholders' Market, and buy or sell units of FSF on the NZX Main Board or ASX. They can effectively exchange shares of FSM for units of FSF and vice versa and therefore can shift between the two markets. The intended result is that shares (FSM) and units (FSF) should trade at very similar prices. This is referred to as the convergence of prices for shares and units. Although there are two separate markets, they have been designed to work together.

### ***3.3 Other Co-operatives***

#### *3.3.1 Westland Co-operative Dairy Company Limited.*

Westland is an independent co-operative dairy company in New Zealand, owned by over 425 farmer shareholders that supply milk for processing locally. In 2001, following the deregulation of the New Zealand dairy industry Westland Milk Products shareholders voted not to join Fonterra and remain independent.

Westland sourced their milk from farms as far Karamea in the north and as far as Haast to the south of the West Coast and from farms throughout Canterbury. Their major processing factory is located in the town of Hokitika, and their main milk concentration plant and warehouse located near the small town of Rolleston outside Christchurch.

### *3.3.2 Tatua Co-operative Dairy Company*

Tatua is an independent small co-operative dairy company in the small rural locality of Tatuanui in the North Island of New Zealand. Tatua co-operative is owned by 112 farmer shareholders, all within a 12-kilometre radius of the processing factory.

The co-operative has maintained a strong independence by becoming the only New Zealand dairy co-operative that remains and has never been part of any merger throughout its history

In the 2001 mega-merger for the New Zealand dairy industry - which formed Fonterra - Tatua shareholders decided to remain independent. Tatua, despite being the smallest dairy company in New Zealand, often records the highest payout for milk solids to its farmer shareholders, one of the main factors why Tatua decided to remain independent. Their high pay-out is mainly due to their focus on value-added milk products as compared to the traditional, mass-produced, of commodity-based milk products such as milk powder, butter and cheese. It is also due to a small catchment area which reduces processing costs.

## ***3.4 Milk today***

The increases in the global supply of milk, coupled with a relatively static demand of milk and dairy products, has seen average dairy prices fall around 50% since early 2014. The price fall affects the incomes of farmers and the New Zealand economy as well. The falling of dairy export has a direct impact on the economy by affecting the dairy manufacturers and farmers. Dairy manufacturers receive less income from export sales and, therefore, reduce incomes to farmers by reducing the farm gate prices. These falling incomes will reduce consumption by the farmer in rural areas, and the farm will try to reduce operational and capital expenses which will reduce revenue and profits of companies that supply the dairy sector. Overall the reduced incomes will eventually translate into lower spending and investment throughout the economy.

# Chapter Four:

# Methodology

## 4. Methodology

### *4.1 Cointegration Analysis*

The study first investigates the relationship between the market index and milk prices measured in NZD. The NZX50 is used as the market index. The two series, the market index and milk prices, are tested for cointegration over the period December 2004 to January 2016. The logarithms of the series are used. They are first tested and found to be random walks, integrated of order one. Such series are cointegrated when there is a long-run linear relationship between them. If there is a linear relationship the difference between the series is not a random walk, but reverts to a common trend. On the other hand if the market index and milk prices are cointegrated then they are a common factor. Milk would not be an additional risk factor that general investors in New Zealand are exposed to in additional to other market risks.

A Granger causality test is also conducted to investigate the impact that changes in milk prices have on the stock index. If the market index and milk prices are not cointegrated it is still possible that milk prices influence the index: milk price might have a partial or delayed effect.

### *4.2 CAPM market model*

After the cointergration analysis, a market model is fitted for all NZX companies, individually. This model regresses the monthly return for each company on the market index and the milk price variable over the period January 2005 to December 2012

$$r_a = \alpha + \beta_a r_M + \gamma r_P + \varepsilon \quad (3)$$

where

$r_a$ is the return on asset a,

$r_M$ is the return on the market index,

and $r_P$ is the log ratio of the monthly milk price variable, $ln(P_t/P_{t-1})$.

This period lies completely in the time before Fonterra Shareholder Fund (FSF) shares were introduced. It is kept short as parameters like beta will change over time.

There are two reasons why Equation (3) is fitted to companies individually, rather than to portfolios of companies as is done by, for instance, Fama and French (1996) and Gillan (1990). Firstly, milk price is not a factor that varies from one company to the next. In each month the milk price variable takes the same value for every company. Forming portfolios of companies would not help isolating a milk price effect. The second reason for fitting Equation (3) to companies individually, is that it allows the market beta to vary from one company to the next. In this way, the various factors like the size effect and the book-to-market effect, which have been found to be risk factors, are taken into account.

The specification of Equation (3) starts with the capital asset pricing model (CAPM). In the CAPM the expected return on a security depends on the sensitivity of its return to the market return.

$$\mathrm{E}(r_a) = r_f + \beta_a(\mathrm{E}(r_M) - r_f) \qquad (4)$$

where

$r_f$ is the Risk free rate,

$\beta_a$ is the Beta of the security,

and $r_M$ is the market return.

In New Zealand over the period 2005 to 2012 there are two different groups of investors. Firstly there are farmer investors who can invest in any shares traded on the NZX, and also shares in Fonterra. Secondly, other investors (non-farmer) who can trade in shares listed on the main board only. Until 2013 these investors could not include exposure to dairy prices directly in their portfolios.

The situation is like looking at the return on non-marketable human capital that is held by an individual. This issue has been explored by Mayers (1972). Mayers extends the two-parameter model of CAPM to include nonmarketable assets such as human capital. The New Zealand dairy farmers are like an individual with a non-marketable

asset. Mayers shows that when an investor is constrained to hold non-marketable assets that have risky rates of return ($r_H$) the CAPM take the following form:

$$E(r_a) = r_f + \lambda[V_M \text{cov}(r_a, r_M) + \text{cov}(r_a, r_H)] \quad (5)$$

Where

$$\lambda = \frac{E(r_M) - r_f}{V_M \, \sigma_M^2 + \text{cov}(r_M, r_H)]} \quad (6)$$

$V_M$ is the current value of all marketable assets,

and $r_H$ is the total return on all nonmarketable assets.

In the above formula covariance is still the measure of risk but we now need to consider the covariance between an asset $a$ and the non-marketable asset as well as with the market index. The log ratio of milk prices is like $r_H$ the return on dairy assets. If the return on another marketable asset $r_a$ is more sensitive to milk prices than the market return $r_M$ is, then its beta will be larger than the usual CAPM. If the return on another marketable asset is less sensitive to milk prices than the market return is, then its beta will be smaller than the usual CAPM.

The relationship between an asset and the milk price will be the source in determining the sign of the coefficient of the milk price variable in Equation (3). An asset which is more sensitive to milk prices than the market return is will result in a positive sign for $\gamma$ in Equation (3). An asset which is less sensitive will give a negative sign for $\gamma$.

*4.3 The period since 2013*

As Fonterra Shareholder Fund (FSF) shares were only listed in January 2013, whereas prior to being listed farmers could only trade their milk shares among themselves, the market model is fitted for the period since 2013 separately and a Chow test conducted

to investigate if there is any difference in coefficients between the two periods. While a different reaction before and after Fonterra shares were listed is an interesting question, it is noted that the period since 2013 is very short, and the test will not be very powerful.

# Chapter Five:

# Data

## *5. Data*

### *5.1 Milk prices*

Monthly milk prices were download from Global Dairy Trade, an auction platform set up by Fonterra to trade commodity dairy products. The Oceania milk power price was used which is representative of Fonterra's price (Understanding Dairy Markets (2016), International Dairy Product Prices).

The price is quoted in USD. It was converted to NZD using the exchange rate downloaded from the Reserve Bank of New Zealand.

### *5.2 The Market index*

The NZX50 is used as the market index. Monthly observations were downloaded from Yahoo Finance.

### *5.3 Company returns*

Prices for company stocks were downloaded from Yahoo Finance. There were 116 companies with sufficient data for analysis over the period analysed. These are listed in Table 1. Companies were categorised by industry based on information from PwC Appreciating Value New Zealand, March 2015. The industries are also indicated in Table 1. Company returns were measured as the log-ratio of prices, $ln(P_t/P_{t-1})$.

Table 1:Companies Categorised by Industry

| Agriculture | Health care | | Retail |
|---|---|---|---|
| A2 Milk | EBOS Group | SmartMIDZ | Hallenstein Glasson Hdg |
| Sanford | Fisher & Paykel Hlthcr | Marlin Global Limited | Michael Hill Intl |
| Allied Farmers Limited | Metlifecare | Smart MOZY | Restaurant Brands NZ |
| Fonterra Shareholder | Pacific Edge Ltd | SmartOZZY | Warehouse Group |
| PGG Wrightson Limited | Ryman Healthcare | Rubicon Limited Ordina | Briscoe Group Limited |
| Seeka Kiwifruit Indust | Abano Healthcare Group | The City of London Ind | The Colonial Motor Cor |
| T&G Global Limited Ord | BLIS Technologies Limi | SmartTENZ | Kathmandu Holdings Lim |
| | Green Cross Health Lim | Veritas Investments | Kircaldie & Stains |
| Construction | | | Pacific Brands Limited |
| Fletcher Building | Indusrial Prodn | Media telecom | Pumpkin Patch Limited |
| Nuplex Industries | Skellerup Holdings | Sky Network Television | Smiths City Group Limi |
| Steel And Tube Holdings | Mercer Group Limited | Spark New Zealand | |
| Downer EDI Limited Ord | Methven Limited Ordina | APN News & Media Limit | Services |
| Tenon Limited Ordinary | Scott Technology Limit | Telstra Corporation | AWF Madison Group Limi |
| | Sealegs Corporation | TeamTalk Limited Ordin | Cleanaway Waste Manage |
| Consumer | Wellington Drive Techn | | Opus International Cor |
| Cavalier Corporation | | Mining | Trade Me Group Limited |
| Comvita Limited Ordina | Information Tech | New Talisman Gold Mi | TRS Investments Limite |
| Delegat Group Limited | Finzsoft Solutions Lim | New Zealand Oil & Gas | Tourism leisure |
| Promisia Integrative | Rakon Limited Ordinary | OceanaGold Corporation | Sky City Entm Gp |
| SeaDragon Limited Ordi | Smartpay Holdings Limi | Pan Pacific Petroleum | Millennium & Copthor |
| Trilogy International | Templeton Emerging M | | Tourism Holdings Limit |
| | VMob Group Limited Ord | Ports | |
| Financial | Xero Limited Ordinary | Auckland Intl Airport | Transport |
| ANZ Banking Group | | Port Of Tauranga | Air New Zealand |
| NZX | Investment | Marsden Maritime Holdi | Freightways |
| Tower | Coats Group | South Port New Zealand | Mainfreight |
| Westpac Banking Corp NZ | Hellaby Holdings | | |
| AMP Limited Ordinary | Infratil | Property | Utilities |
| ASB Capital Limited | Australian Foundation | Argosy Property | Contact Energy |
| Heartland Bank Limited | Aorere Resources Limit | Goodman Property Trust | New Zealand Refining |
| Pyne Gould Corporation | Bethunes Investments | Kiwi Property Group | Trustpower |
| Turners Limited Ordina | The Bankers Investment | Precinct Properties NZ | Vector Ltd |
| | Barramundi Limited O | Property For Industry | Chorus Limited (NS) |
| | SmartFONZ | Vital Healthcare Pr Tst | |
| | Henderson Far East Ind | Augusta Capital Limite | |
| | JPMorgan Japanese Indu | CDL Investments New | |
| | Kingfish Limited Ordin | NPT Limited Ordinary | |

# Chapter Six:

# Results

## *6. Results*

### *6.1 Cointegration Analysis*

This section reports the results of the cointegration analysis performed on the two series, the NZX50 and milk prices measured in NZD. The logarithms of both series were used. Cointegration exists when there is a long-run linear relationship between two series both integrated of the same order, one. An augmented Dickey–Fuller test (ADF) developed by Dickey and Fuller (1979, 1981) is used to test whether they have unit roots. The augmented Dickey–Fuller (ADF) statistic, used in this test, is a negative number. The more negative it is, the stronger the rejection of the hypothesis that there is a unit root at some level of confidence. The statistical output of the tests are contained in Appendix 1, and the results summarised in Table 2.

Table 2: ADF test for unit roots

| | Z value | 5% Critical value |
|---|---|---|
| NZX50 | -1.751 | -3.446 |
| Milk Price in NZD | -2.279 | -3.446 |

From the table, it is seen that both NZX50 and Milk prices have Z values higher than the 5% Critical value. The tests fail to reject null hypotheses of unit roots. So NZX50 and Milk prices are each not stationary, and the conclusion is that they are integrated of order one. The series might be cointegrated.

To test whether the series are cointegrated the procedure in Engle and Granger (1987) is followed. The logarithm of the market index is regressed on the logarithm of the milk price variable and the residuals tested for stationarity using the ADF test. If the residuals have a unit root they are not stationary and the conclusion is that the two series are not cointegrated. The results from this procedure are in Appendix 2 and the unit root test on the residuals is summarised in Table 3.

Table 3: ADF test for unit root on residuals from regressing log NZX50 on log milk price

| | Z value | 5% Critical value |
|---|---|---|
| Residuals | -2.494 | -2.888 |

Since the Z value is bigger than the 5% critical value the null hypothesis cannot be rejected at this level. I conclude that the residual has a unit root and is not stationary and therefore that the NZX50 and milk prices are not cointegrated. This supports the conclusion that milk price has an independent stochastic trend and could be an additional risk factor besides market risk.

### *6.1.1 Granger Causality test*

Since the market index and milk price variable are not cointegrated, they are not linearly related in the long-run. The milk price variable might still be a leading variable for the market index. A Granger Causality test was conducted to investigate this for three periods: 2005-2012, 2013-2015 and for the combined period 2005-2015. Monthly observations and the logarithms of data were used, and the variables each lagged to four periods. The statistical output is in Appendix 3, and summarised in Table 4. It is noted that four observations are lost in each fit due to lagging four periods.

Table 4: Results of Granger Causality tests.

| | | | |
|---|---|---|---|
| Period | 2005-2012 | 92 obsns | P = 0.0355 |
| | 2013-2015 | 33 obsns | P= 0.5857 |
| Combined | 2005-2015 | 129 obsns | P= 0.0811 |

In each case, the null hypothesis is that the coefficients of the four lags of the milk price variable are jointly zero.

The null hypothesis is rejected at the 5% level of significance for the first period, 2005-2012. There is evidence that milk prices Granger-cause market return over this period. Some milk price risk is priced by the market index, with a lagged effect.

It is interesting that the null hypothesis cannot be rejected for the second period, 2013-2015. This period is very short, and the test, therefore, does not have much power. When the two periods are combined, the null hypothesis cannot be rejected at the 5% level of significance. There is some evidence that the relationship between the market index and milk prices has changed with the introduction of Fonterra Shareholder Fund (FSF) shares to the NZX.

## *6.2 CAPM market model January 2005 to December 2012*

### *6.2.1 Estimates of milk price coefficients*

The results from fitting Equation (3) on page 28 to 115 companies on the NZX using monthly return from January 2005 to December 2012 are presented in Appendix 4. Not all these companies were present for the whole period, but were fitted for the period they were available. The main variable of interest is the estimated coefficient of the milk variable. This is summarised in Table 5, and the cases where the coefficient is significantly different from zero are listed in table 6, it shows that all the estimated coefficients were small. The range was -0.475 to 0.342.

Table 5: Milk coefficient estimated over 2005 to 2012

| | **Negative** | **Positive** |
|---|---|---|
| Milk coefficient | 58 Cases | 57 Cases |
| Significant at: | | |
| 5% level | 2 Cases | 5 Cases |
| 10% level | 6 Cases | 6 Cases |

Table 6: Companies with significant milk coefficients

| | | Company | Industry | Coef. | t |
|---|---|---|---|---|---|
| Positive at | 5% level | Fletcher Building | Construction | 0.156 | 2.298 |
| | | Sanford | Agriculture | 0.158 | 2.395 |
| | | JPMorgan Japanese | Investment | 0.342 | 2.027 |
| | | Kircaldie & Stains | Retail | 0.172 | 2.601 |
| | | Opus Int. Corb. | Services | 0.196 | 2.043 |
| | 10% level | Henderson Far East | Investment | 0.353 | 1.742 |
| Negative at | 5% level | Spark New Zealand | Telecom | -0.200 | -2.428 |
| | | Pan Pacific Petroleum | Mining | -0.475 | -2.550 |
| | 10% level | Air New Zealand | Transport | -0.215 | -1.894 |
| | | EBOS Group | Healthcare | -0.111 | -1.893 |
| | | Kiwi Property Group | Property | -0.089 | -1.940 |
| | | Green Cross Health | Healthcare | -0.367 | -1.813 |

The number of significant cases is not much different from random in 115 fits. However for many companies the economic effect of milk prices would be very small and statistical significance from zero would not be expected anyway. Some significant cases might be explained using Mayers' extension to the CAPM. For example, Fletcher Building has a positive milk coefficient with t=2.298. Farmers' building activity might be more sensitive to dairy farmer incomes than other investors'. The EBOS milk coefficient is negative with t=-1.893. This company has interests in animal care. Animal costs might be fixed and farmers' activity less sensitive to dairy farmer incomes than others investors'.

### *6.2.2 Patterns in milk price coefficients*

The study also looked for patterns in the estimated milk coefficients. According to Fisher:

> The most impressive kind of econometric result is not that of goodness of fit but that of a striking and plausible pattern in the point estimates obtained by treating similar problems in a similar way. (Fisher, 1962)

The estimated coefficients were regressed on dummy variables for the 17 industry groupings in Table 1. Because the coefficients are estimated, weighted least squares was used. The reciprocals of standard errors of the estimated milk coefficients were used for weights so that companies with large standard errors have smaller influences on the results. The results are presented in table 7.

**Table 7: Regression of milk coefficients on industry groupings, 2005-2012**

| Industry | Effect | t |
|---|---|---|
| Agriculture | 0.100 | 2.043 |
| Construction | 0.067 | 1.334 |
| Consumer | 0.117 | 1.613 |
| Financial | -0.014 | -0.404 |
| Health Care | -0.053 | -1.327 |
| Industrial Prodn | 0.048 | 0.829 |
| Information Tech | -0.024 | -0.380 |
| Investment | 0.001 | 0.059 |
| Media telecom | -0.077 | -2.061 |
| Mining | -0.071 | -0.762 |
| Ports | 0.030 | 0.771 |
| Property | -0.051 | -2.519 |
| Retail | 0.036 | 1.196 |
| Services | 0.104 | 1.282 |
| Tourism Leisure | 0.029 | 0.570 |
| Transport | -0.036 | -0.804 |
| Utilities | -0.011 | -0.347 |
| R-Squared=0.217 | P=0.059 | |

There is a plausible Pattern. The regression is significant at the 10% level, and almost at the 5% level. Industries where there would be an elastic income effect, such as Construction, Consumer, Retail and Services have positive effects. Industries where income effects are probability inelastic, such as Financial, HealthCare, Media, Property, Transport and Utilities have negative effects.

*6.2.3 Size of milk price effect*

To assess the economic significance of a milk effect, it is necessary to go back to Mayers' CAPM formula given in Equations (5) and (6) on page 30. Mayers' formula gives an adjustment to the quantity of risk given by the usual CAPM beta. The adjustment depends on the current value of all marketable assets, $V_M$ and the total return to dairy farmers (all non-marketable assets), $r_H$. Estimating $r_H/V_M$ by the contribution to NZ GDP which is about 2.8% (Stuff, 2011), the adjustment to the usual CAPM beta is calculated for a range of parameters for the first period in Table 8.

**Table 8: Estimated adjustment to be the usual CAPM beta, 2005-2012**

| | **Milk Coefficient, σ** | |
|---|---|---|
| | **-0.3** | **0.3** |
| **β = 0.8** | **-0.033** | **0.029** |
| **β = 1.5** | **-0.035** | **0.028** |

For typical values observed for beta and the milk coefficient the adjustment is in all cases less than four percentage points. This is consistent with Fama's and Schwert's (1977) observation that "the model that includes human capital leads to estimates of risk for marketable assets indistinguishable from those of the simpler models."

*6.3 The period since 2013*

The results from fitting Equation (3) on page 28 to the period January 2013 to 1 April 2016 to 116 companies are presented in Appendix 5. These are the companies for which data was available for this period. The estimated coefficients of the milk variable are summarised in Table 9, and the cases with coefficients that are significantly different from zero are listed in Table 10.

Table 9: Companies with significant milk coefficients

| | | Company | Industry | Coef. | t |
|---|---|---|---|---|---|
| Positive at | 5% level | EBOS Group | Healthcare | 0.211 | 2.778 |
| | | Madison Group | Services | 0.199 | 2.508 |
| | | Xero Limited | Information Technology | 0.522 | 2.411 |
| | 10% level | Marsden Maritime | Ports | 0.088 | 1.724 |
| | | SmartTENZ | Investment | 0.026 | 1.727 |
| Negative at | 5% level | Smiths City Group | Retail | -0.133 | -2.165 |
| | | Veritas Investments | Investment | -0.307 | -1.968 |
| | 10% level | Tower | Financial | -0.213 | -1.808 |
| | | Chorus Limited | Utilities | -0.280 | -1.880 |
| | | Rakon Limited | Information Technology | -0.342 | -1.914 |

Table 10: Milk coefficient estimated over 2013 to 2016

| | **Negative** | **Positive** |
|---|---|---|
| Milk coefficient | 64 Cases | 52 Cases |
| Significant at: | | |
| 5% level | 2 Cases | 3 Cases |
| 10% level | 5 Cases | 5 Cases |

There is again some significant cases that might be expected at random in 116 regressions. However, a weighted regression of milk coefficients on industry groupings in Table 11, no longer has the patterns observed in Table 7 for the first period. Therefore there is some evidence that a change has taken place since 2013. However, because the second period is short, the tests here are not very powerful. In fact the Chow test to test constancy of the milk coefficients between the two periods found no significant differences in all cases where the companies were present in both periods.

| Table 11: Regression of milk coefficients on industry groupings, 2013-2016 | | |
|---|---|---|
| **Industry** | **Effect** | **t** |
| Agriculture | 0.003 | 0.081 |
| Construction | -0.012 | -1.069 |
| Consumer | 0.024 | 0.455 |
| Financial | 0.004 | 0.159 |
| Health Care | 0.030 | 0.978 |
| Industrial Prodn | 0.054 | 1.130 |
| Information Tech | -0.075 | -1.293 |
| Investment | 0.012 | 1.456 |
| Media telecom | -0.034 | -0.876 |
| Mining | -0.093 | -1.507 |
| Ports | 0.039 | 1.588 |
| Property | 0.021 | 1.504 |
| Retail | -0.016 | -0.730 |
| Services | 0.030 | 0.720 |
| Tourism Leisure | -0.023 | -0.494 |
| Transport | -0.033 | -0.915 |
| Utilities | -0.032 | -1.072 |
| R-Squared=0.156 | P=0.324 | |

# Chapter Seven:

# Conclusions

## *7.0 Conclusions*

This study was motivated by the importance of milk prices to the New Zealand economy, and possible market imperfections due to the largest dairy company, Fonterra, being a cooperative. Before 2013 exposure to milk price risk mainly affected farmers. The study investigated whether milk price was an additional factor that investors in New Zealand are exposed to in addition to other market risks that are measured by the NZX50.

Some evidence of a small milk price effect was found over the period 2005 to 2012. There was also some evidence of a change when the Fonterra Shareholders' Fund was created in 2013, but there is insufficient data since 2013 for powerful statistical tests. Below are the findings to the four specific questions that were posed.

*1. What are the characteristics that would make the risk of an asset greater or lower in the presence of milk price risk?*

The study adopted Mayers' (1972) extension of the CAPM to nonmarketable assets. In Mayers' formula, the covariance is still the measure of risk, but we now need to consider the covariance with total return on nonmarketable assets. Applying Mayers' formula indicated that if the return on another marketable asset is more sensitive to milk prices than it is to the market return, its beta will be larger than the usual CAPM beta, and if the return on another marketable asset is less sensitive to milk prices than the average market return, its beta will be smaller than the usual CAPM.

*2. Does milk price risk have an observable price in New Zealand, or is it completely diversified?*

From the cointegration analysis reported in chapter 6.1, the conclusion is that milk price risk has not been completely diversified away. ADF tests supported the conclusion that the market index and the milk price variables are both integrated of order one, and from the Engle and Granger procedure the conclusion was that they are not cointegrated. Milk price has an independent stochastic trend. Milk price could be an additional risk factor beside market risk. Fitting the CAPM market model in chapter 6.2 to the period 2005-2012 showed several cases of significant coefficients for the milk

price variable. All the estimated coefficients were small. The range was -0.475 to 0.342. The adjustment to the usual CAPM beta was estimated to be less than four percentage points. The conclusion is that milk price risk did have an observable price over this period but that its economic significance is small.

*3. Is there evidence of a milk price effect on assets in New Zealand?*

Referring to chapter 6.2.2 on the study of patterns in milk price coefficients over the period 2005-2012 the results did show evidence of a milk price effect on assets. Industries where there would be an elastic income effect, such as Construction, Consumer, Retail, and Services have a positive milk price effect. Industries where income effects would be inelastic, such as Financial, HealthCare, Media, Property, Transport and Utilities have a negative milk price effect.

*4. Is there evidence of a change in the effect of milk price risk following the change to Fonterra's capital structure in 2013?*

There is evidence of a change in the milk price risk following the creation of the Fonterra Shareholders' Fund in 2013, though the small period available since 2013 limited the power of the statistical tests. A Granger Causality test conducted for three periods, 2005-2012, 2013-2015 and for the combined period 2005-2015, indicated that a causal relationship between the NZX50 and milk prices in the first period, changes. Also, the patterns by industry observed for the estimated milk price effects over 2005-2012, were not observed for the period 2013-2016.

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## 7.1 Future research

The period since the creation of the Fonterra Shareholders' Fund limited the power of the statistical tests in this study. Future research might investigate Granger Causality and fit the CAPM market model over a longer period since the change.

The milk price variable in this study was measured in NZD, whereas the original variable is measured in USD. Since the returns to dairy farmers come mainly from

overseas earnings, future research might investigate whether the effect found for milk prices might be influence by the exchange rate.

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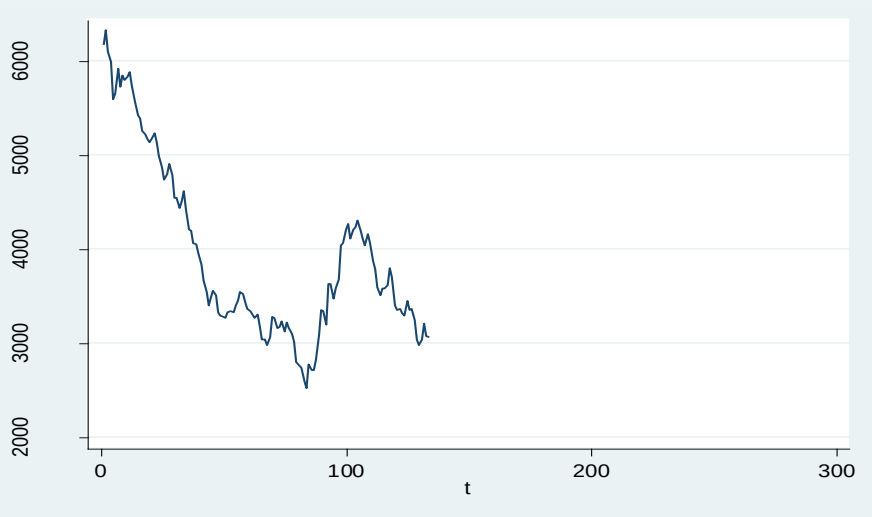
# Appendices

# Appendix 1

## ADF test for unit roots

# Unit Root Test

## 2005-2012




## NZX50

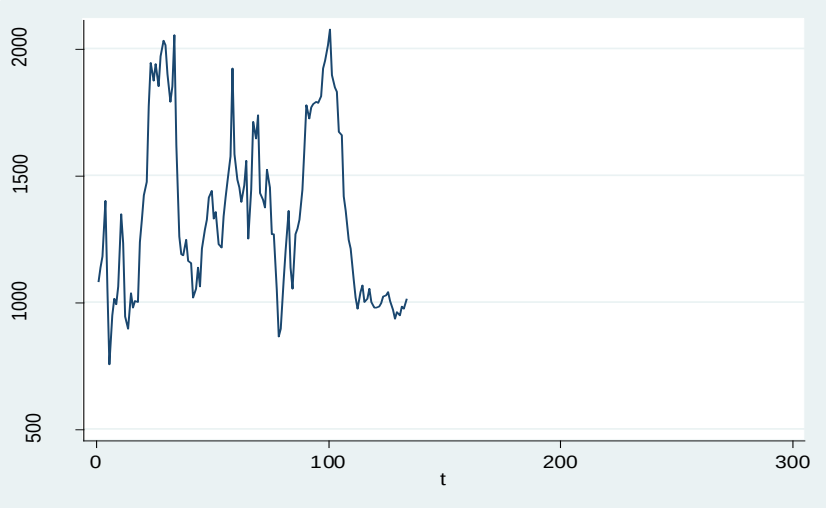
```
. dfuller NZX50, trend regress lags(2)

Augmented Dickey-Fuller test for unit root         Number of obs   =       131

                                 ------------ Interpolated Dickey-Fuller ------------
                    Test         1% Critical       5% Critical      10% Critical
                 Statistic           Value             Value            Value
------------------------------------------------------------------------------
 Z(t)            -1.751            -4.030            -3.446           -3.146
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.7277

------------------------------------------------------------------------------
D.NZX50 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       NZX50 |
        L1. |  -.0289786   .0165451    -1.75   0.082    -.0617209    .0037638
        LD. |   .1354382   .0867317     1.56   0.121    -.0362012    .3070777
       L2D. |  -.0977104   .0863962    -1.13   0.260     -.268686    .0732651
     _trend |  -.0028653   .3995747    -0.01   0.994     -.793612    .7878814
     _cons |   91.08592   86.23359     1.06   0.293    -79.56782    261.7397
------------------------------------------------------------------------------
```

Z value (-1.751) > 5% Critical Value (-3.446)

Fail to reject H0

Has a unit root and it is not stationary

NXZ50 = I (1)




## Milk NZD

```
. dfuller MilkNZD, trend regress lags(2)

Augmented Dickey-Fuller test for unit root        Number of obs   =       131

                                 ------------ Interpolated Dickey-Fuller ------------
                    Test         1% Critical       5% Critical      10% Critical
                 Statistic           Value             Value            Value
------------------------------------------------------------------------------
 Z(t)            -2.279             -4.030            -3.446           -3.146
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.4456

------------------------------------------------------------------------------
D.MilkNZD |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-----------+------------------------------------------------------------------
MilkNZD   |
      L1. |  -.0834785   .0366286    -2.28   0.024    -.1559655   -.0109916
      LD. |   .1423286   .0879072     1.62   0.108    -.0316371    .3162944
     L2D. |  -.1072559   .0885997    -1.21   0.228    -.2825921    .0680804
   _trend |  -.2580429   .3121071    -0.83   0.410    -.8756937    .3596079
    _cons |   129.3648   56.96251     2.27   0.025     16.63767    242.0919
------------------------------------------------------------------------------
```

Z value (-2.279) > 5% Critical Value (-3.446)

Fail to reject H0

Has a unit root and it is not stationary

Milk NZD = I (1)

# Appendix 2

## Unit Root test on Residuals

## 2005-2012

```
.
. regress NZX50 MilkNZD
```

| Source | SS | df | MS | Number of obs | = | 134 |
|---|---|---|---|---|---|---|
| | | | | F(1, 132) | = | 0.23 |
| Model | 205497.205 | 1 | 205497.205 | Prob > F | = | 0.6310 |
| Residual | 117026145 | 132 | 886561.708 | R-squared | = | 0.0018 |
| | | | | Adj R-squared | = | -0.0058 |
| Total | 117231643 | 133 | 881440.922 | Root MSE | = | 941.57 |

| NZX50 | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| MilkNZD | .1163806 | .2417308 | 0.48 | 0.631 | -.3617869 | .594548 |
| _cons | 3768.54 | 335.7532 | 11.22 | 0.000 | 3104.387 | 4432.693 |

```
.
. //Residual test
. predict double resid, residuals
(138 missing values generated)

.
. //ADF resid
. dfuller resid
```

Dickey-Fuller test for unit root — Number of obs = 133

| | Test Statistic | 1% Critical Value | 5% Critical Value | 10% Critical Value |
|---|---|---|---|---|
| | | Interpolated Dickey-Fuller | | |
| Z(t) | -2.494 | -3.499 | -2.888 | -2.578 |

MacKinnon approximate p-value for Z(t) = 0.1169

The Z value (-2.494) > 5% Critical Value (-2.888)

Fail to reject H0

Residual has a unit root

Series (NZX50 and Milk NZD) are Not Cointegrated

# Appendix 3

## Granger Causality test

4 lagged

2005-2012

```
. set more off

.
. gen time=_n

. tsset time
        time variable:  time, 1 to 97
                delta:  1 unit

.
. //Do MilkNZD Granger-cause Marketreturn
. **regress Marketreturn L.Marketreturn L.MilkNZD
. regress Marketreturn L(1/4).Marketreturn L(1/4).MilkNZD
```

| Source | SS | df | MS | Number of obs | = | 92 |
|---|---|---|---|---|---|---|
| | | | | F(8, 83) | = | 2.19 |
| Model | .022555275 | 8 | .002819409 | Prob > F | = | 0.0362 |
| Residual | .106813256 | 83 | .001286907 | R-squared | = | 0.1743 |
| | | | | Adj R-squared | = | 0.0948 |
| Total | .129368531 | 91 | .001421632 | Root MSE | = | .03587 |

| Marketreturn | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| Marketreturn | | | | | | |
| L1. | .0791699 | .1089651 | 0.73 | 0.470 | -.1375573 | .2958971 |
| L2. | -.2045503 | .1068104 | -1.92 | 0.059 | -.4169919 | .0078913 |
| L3. | .1316599 | .1072658 | 1.23 | 0.223 | -.0816875 | .3450072 |
| L4. | .0503281 | .1058668 | 0.48 | 0.636 | -.1602367 | .260893 |
| MilkNZD | | | | | | |
| L1. | .0433989 | .0533778 | 0.81 | 0.419 | -.0627674 | .1495653 |
| L2. | .104827 | .0545147 | 1.92 | 0.058 | -.0036005 | .2132546 |
| L3. | .089821 | .0551824 | 1.63 | 0.107 | -.0199345 | .1995765 |
| L4. | .0462625 | .0559154 | 0.83 | 0.410 | -.0649511 | .157476 |
| _cons | .0009517 | .0037773 | 0.25 | 0.802 | -.0065612 | .0084646 |

```
.
. **test L.MilkNZD
. test L1.MilkNZD L2.MilkNZD L3.MilkNZD L4.MilkNZD

 ( 1)  L.MilkNZD = 0
 ( 2)  L2.MilkNZD = 0
 ( 3)  L3.MilkNZD = 0
 ( 4)  L4.MilkNZD = 0

       F(  4,    83) =    2.71
            Prob > F =    0.0355

.
end of do-file
```

```
. set more off

.
. gen time=_n

. tsset time
        time variable:  time, 1 to 38
                delta:  1 unit

.
. //Do MilkNZD Granger-cause Marketreturn
. **regress Marketreturn L.Marketreturn L.MilkNZD
. regress Marketreturn L(1/4).Marketreturn L(1/4).MilkNZD
```

| Source | SS | df | MS | Number of obs | = | 33 |
|---|---|---|---|---|---|---|
| | | | | F(8, 24) | = | 1.59 |
| Model | .0059216 | 8 | .0007402 | Prob > F | = | 0.1809 |
| Residual | .011189945 | 24 | .000466248 | R-squared | = | 0.3461 |
| | | | | Adj R-squared | = | 0.1281 |
| Total | .017111545 | 32 | .000534736 | Root MSE | = | .02159 |

| Marketreturn | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| Marketreturn | | | | | | |
| L1. | -.1627366 | .1730625 | -0.94 | 0.356 | -.51992 | .1944469 |
| L2. | -.4389006 | .1718179 | -2.55 | 0.017 | -.7935152 | -.084286 |
| L3. | -.1543161 | .1679407 | -0.92 | 0.367 | -.5009287 | .1922965 |
| L4. | -.4353458 | .1713257 | -2.54 | 0.018 | -.7889446 | -.081747 |
| MilkNZD | | | | | | |
| L1. | .0178114 | .0356773 | 0.50 | 0.622 | -.0558229 | .0914457 |
| L2. | .0298207 | .0349672 | 0.85 | 0.402 | -.042348 | .1019895 |
| L3. | .0268894 | .0319677 | 0.84 | 0.409 | -.0390886 | .0928674 |
| L4. | .0400264 | .0354256 | 1.13 | 0.270 | -.0330885 | .1131413 |
| _cons | .0226619 | .0057535 | 3.94 | 0.001 | .0107872 | .0345366 |

```
.
. **test L.MilkNZD
. test L1.MilkNZD L2.MilkNZD L3.MilkNZD L4.MilkNZD

 ( 1)  L.MilkNZD = 0
 ( 2)  L2.MilkNZD = 0
 ( 3)  L3.MilkNZD = 0
 ( 4)  L4.MilkNZD = 0

       F(  4,    24) =    0.72
            Prob > F =    0.5857

.
end of do-file

.
```

```
. set more off

.
. gen time=_n

. tsset time
        time variable:  time, 1 to 134
                delta:  1 unit

.
. //Do MilkNZD Granger-cause Marketreturn
. **regress Marketreturn L.Marketreturn L.MilkNZD
. regress Marketreturn L(1/4).Marketreturn L(1/4).MilkNZD
```

| Source | SS | df | MS | Number of obs | = | 129 |
|---|---|---|---|---|---|---|
| | | | | F(8, 120) | = | 2.10 |
| Model | .018509527 | 8 | .002313691 | Prob > F | = | 0.0407 |
| Residual | .132143634 | 120 | .001101197 | R-squared | = | 0.1229 |
| | | | | Adj R-squared | = | 0.0644 |
| Total | .150653161 | 128 | .001176978 | Root MSE | = | .03318 |

| Marketreturn | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| Marketreturn | | | | | | |
| L1. | .1137083 | .0903746 | 1.26 | 0.211 | -.0652271 | .2926437 |
| L2. | -.1934952 | .0894666 | -2.16 | 0.033 | -.3706328 | -.0163575 |
| L3. | .1306639 | .0901435 | 1.45 | 0.150 | -.0478139 | .3091417 |
| L4. | .019708 | .0890694 | 0.22 | 0.825 | -.1566433 | .1960593 |
| MilkNZD | | | | | | |
| L1. | .0402016 | .0355828 | 1.13 | 0.261 | -.0302499 | .1106531 |
| L2. | .0602322 | .0357189 | 1.69 | 0.094 | -.0104888 | .1309532 |
| L3. | .0485517 | .0343838 | 1.41 | 0.161 | -.0195258 | .1166292 |
| L4. | .0347619 | .0347604 | 1.00 | 0.319 | -.0340612 | .103585 |
| _cons | .0039437 | .0030487 | 1.29 | 0.198 | -.0020925 | .00998 |

```
.
. **test L.MilkNZD
. test L1.MilkNZD L2.MilkNZD L3.MilkNZD L4.MilkNZD

 ( 1)  L.MilkNZD = 0
 ( 2)  L2.MilkNZD = 0
 ( 3)  L3.MilkNZD = 0
 ( 4)  L4.MilkNZD = 0

       F(  4,   120) =    2.13
            Prob > F =    0.0811

.
end of do-file

.
```

# Appendix 4

## Result from fitting the CAPM market model,

## 2005-2012

Result from fitting the CAPM market model, 2005-2012

| Beta | Constant | Beta | Milk Coef | P Value | # 0f Obs |
|---|---|---|---|---|---|
| Auckland Intl Airport | 0.005 | 0.8619 | 0.073 | 0.000000 | 97 |
| | (0.0050) | (0.1363) | (0.0704) | | |
| Air New Zealand | -0.0026 | 1.3211 | -0.2152 | 0.000000 | 97 |
| | (0.0081) | (0.2201) | (0.1136) | | |
| ANZ Banking Group | 0.0035 | 0.7946 | -0.0913 | 0.000011 | 97 |
| | (0.0058) | (0.1562) | (0.0806) | | |
| Argosy Property | 0.0089 | 0.7493 | -0.0739 | 0.000434 | 51 |
| | (0.0058) | (0.1819) | (0.0694) | | |
| A2 Milk | -0.0018 | 1.5649 | -0.3127 | 0.044859 | 97 |
| | (0.0234) | (0.6344) | (0.3276) | | |
| Contact Energy | -0.0021 | 1.0429 | -0.0299 | 0.000000 | 97 |
| | (0.0043) | (0.1170) | (0.0604) | | |
| Coats Group | -0.0125 | 1.4208 | 0.0354 | 0.000000 | 96 |
| | (0.0071) | (0.1902) | (0.0982) | | |
| EBOS Group | 0.0065 | 0.7714 | -0.1107 | 0.000000 | 97 |
| | (0.0042) | (0.1132) | (0.0585) | | |
| Fletcher Building | 0.0019 | 1.3998 | 0.1555 | 0.000000 | 97 |
| | (0.0048) | (0.1311) | (0.0677) | | |
| Fisher & Paykel Hlthcr | -0.0021 | 0.5604 | 0.0503 | 0.004513 | 97 |
| | (0.0063) | (0.1717) | (0.0887) | | |
| Freightways | 0.004 | 0.8204 | 0.0025 | 0.000000 | 97 |
| | (0.0043) | (0.1159) | (0.0599) | | |
| Goodman Property Trust | 0 | 0.699 | -0.0883 | 0.000002 | 72 |
| | (0.0048) | (0.1270) | (0.0603) | | |
| Hellaby Holdings | -0.0092 | 1.7965 | -0.2045 | 0.000003 | 97 |
| | (0.0123) | (0.3334) | (0.1722) | | |
| Hallenstein Glasson Hdg | 0.0033 | 1.0716 | -0.037 | 0.000000 | 97 |
| | (0.0058) | (0.1558) | (0.0805) | | |
| Infratil | 0.0021 | 1.1498 | 0.036 | 0.000000 | 97 |
| | (0.0043) | (0.1160) | (0.0599) | | |
| Kiwi Property Group | 0.0026 | 0.6302 | -0.0893 | 0.000006 | 51 |
| | (0.0038) | (0.1206) | (0.0460) | | |
| Mainfreight | 0.0158 | 1.1284 | -0.0118 | 0.000000 | 97 |
| | (0.0065) | (0.1761) | (0.0909) | | |
| Metlifecare | -0.0029 | 1.0466 | 0.1183 | 0.000018 | 97 |
| | (0.0082) | (0.2216) | (0.1144) | | |
| Michael Hill Intl | 0.0029 | 1.0013 | 0.0954 | 0.000004 | 97 |
| | (0.0072) | (0.1942) | (0.1003) | | |
| Nuplex Industries | -0.0151 | 1.44 | 0.0972 | 0.000633 | 96 |
| | (0.0137) | (0.3695) | (0.1908) | | |

@ SE in parentheses. continued

continued

Result from fitting the CAPM market model, 2005-2012

| | Constant | Beta | Milk Coef | P Value | # 0f Obs |
|---|---|---|---|---|---|
| NZX | 0.0126 | 1.1405 | 0.1279 | 0.002031 | 97 |
| | (0.0121) | (0.3289) | (0.1698) | | |
| New Zealand Refining | 0.01 | 0.4685 | -0.0346 | 0.438093 | 97 |
| | (0.0133) | (0.3605) | (0.1862) | | |
| Precinct Properties NZ | 0.0008 | 0.3638 | -0.0709 | 0.135375 | 48 |
| | (0.0066) | (0.1998) | (0.0819) | | |
| Pacific Edge Ltd | 0.0082 | 0.1995 | 0.119 | 0.828413 | 97 |
| | (0.0194) | (0.5261) | (0.2717) | | |
| Property For Industry | 0.0059 | 0.3015 | -0.0306 | 0.001862 | 97 |
| | (0.0030) | (0.0818) | (0.0423) | | |
| Port Of Tauranga | 0.0085 | 0.7382 | 0.0312 | 0.000001 | 97 |
| | (0.0049) | (0.1335) | (0.0690) | | |
| Restaurant Brands NZ | 0.0095 | 0.6509 | -0.0489 | 0.015091 | 97 |
| | (0.0081) | (0.2182) | (0.1127) | | |
| Ryman Healthcare | 0.0329 | 1.2052 | 0.1232 | 0.04714 | 97 |
| | (0.0185) | (0.5006) | (0.2585) | | |
| Sanford | 0.0015 | 0.388 | 0.1578 | 0.00044 | 97 |
| | (0.0047) | (0.1276) | (0.0659) | | |
| Sky City Entm Gp | -0.0026 | 1.1165 | -0.0092 | 0.00000 | 97 |
| | (0.0046) | (0.1247) | (0.0644) | | |
| Skellerup Holdings | 0.0041 | 1.1862 | -0.098 | 0.000005 | 97 |
| | (0.0082) | (0.2223) | (0.1148) | | |
| Sky Network Television | -0.0028 | 0.8581 | -0.0569 | 0.000000 | 96 |
| | -0.0049 | -0.1322 | -0.0683 | | |
| Spark New Zealand | -0.0078 | 1.143 | -0.2004 | 0.000000 | 97 |
| | (0.0059) | (0.1598) | (0.0825) | | |
| Steel And Tube Holdings | -0.0081 | 1.2335 | -0.1058 | 0.000000 | 97 |
| | (0.0067) | (0.1820) | (0.0940) | | |
| Trustpower | 0.0046 | 0.6196 | -0.0359 | 0.000000 | 97 |
| | (0.0033) | (0.0896) | (0.0462) | | |
| Tower | -0.0016 | 0.9214 | 0.0623 | 0.000420 | 97 |
| | (0.0085) | (0.2296) | (0.1186) | | |
| Vector Ltd | 0.0004 | 0.5628 | 0.0925 | 0.000444 | 89 |
| | -0.0055 | -0.1491 | -0.074 | | |
| Vital Healthcare Pr Tst | 0.0089 | 0.2743 | -0.0377 | 0.243054 | 51 |
| | (0.0054) | (0.1716) | (0.0655) | | |
| Westpac Banking Corp NZ | 0.0047 | 1.0389 | -0.053 | 0.000000 | 97 |
| | (0.0061) | (0.1657) | (0.0855) | | |

@ SE in parentheses. continued

continued

Result from fitting the CAPM market model, 2005-2012

| | Constant | Beta | Milk Coef | P Value | # 0f Obs |
|---|---|---|---|---|---|
| Warehouse Group | 0.0008 | 0.686 | -0.0247 | 0.010492 | 97 |
| | (0.0081) | (0.2205) | (0.1138) | | |
| Abano Healthcare Group | 0.0169 | 0.9738 | -0.1757 | 0.000362 | 97 |
| | (0.0088) | (0.2386) | (0.1232) | | |
| Australian Foundation | 0.001 | 0.7023 | -0.0712 | 0.038138 | 58 |
| | (0.0104) | (0.2707) | (0.1476) | | |
| Allied Farmers Limited | -0.0948 | 1.3707 | -0.2117 | 0.222653 | 97 |
| | (0.0292) | (0.7909) | (0.4084) | | |
| AMP Limited Ordinary | -0.0035 | 1.115 | -0.0911 | 0.000000 | 97 |
| | (0.0058) | (0.1578) | (0.0815) | | |
| Aorere Resources Limit | -0.005 | 1.9796 | 0.11 | 0.002450 | 95 |
| | (0.0208) | (0.5741) | (0.3043) | | |
| APN News & Media Limit | -0.029 | 1.2305 | 0.0493 | 0.000467 | 97 |
| | (0.0113) | (0.3054) | (0.1577) | | |
| ASB Capital Limited | -0.0024 | 0.642 | 0.092 | 0.001043 | 55 |
| | (0.0070) | (0.1738) | (0.0932) | | |
| Augusta Capital Limite | -0.0027 | 0.8911 | -0.0143 | 0.000000 | 73 |
| | (0.0048) | (0.1288) | (0.0604) | | |
| AWF Madison Group Limi | 0.0094 | 0.1193 | -0.1601 | 0.611116 | 90 |
| | (0.0122) | (0.3324) | (0.1651) | | |
| Briscoe Group Limited | 0.0087 | 1.0466 | -0.0794 | 0.000000 | 97 |
| | (0.0060) | (0.1617) | (0.0835) | | |
| Bethunes Investments | 0.0024 | 0.6658 | 0.4146 | 0.304999 | 88 |
| | (0.0267) | (0.6949) | (0.3724) | | |
| The Bankers Investment | 0.0024 | 0.8048 | -0.0256 | 0.000000 | 97 |
| | (0.0032) | (0.0856) | (0.0442) | | |
| BLIS Technologies Limi | -0.0188 | -0.4256 | 0.1162 | 0.753922 | 97 |
| | (0.0224) | (0.6062) | (0.3130) | | |
| Barramundi Limited O | -0.0017 | 0.8212 | -0.2689 | 0.146553 | 75 |
| | (0.0181) | (0.4839) | (0.2269) | | |
| Cavalier Corporation | -0.0103 | 1.4479 | 0.1103 | 0.000001 | 97 |
| | (0.0095) | (0.2580) | (0.1332) | | |
| CDL Investments New | 0.0039 | 0.6409 | -0.0398 | 0.002517 | 97 |
| | (0.0066) | (0.1781) | (0.0920) | | |
| The Colonial Motor Cor | 0.0064 | 0.2171 | 0.0147 | 0.348681 | 97 |
| | (0.0056) | (0.1525) | (0.0787) | | |
| Chorus Limited (NS) | -0.0446 | 2.1533 | -0.2534 | 0.046094 | 14 |
| | (0.0250) | (0.8555) | (0.4065) | | |
| Comvita Limited Ordina | 0.0032 | 0.996 | 0.2444 | 0.001388 | 97 |
| | (0.0114) | (0.3073) | (0.1587) | | |
| Cleanaway Waste Manage | -0.088 | 14.7374 | 6.8065 | 0.487232 | 37 |
| | (0.6060) | (15.8868) | (9.9478) | | |

@ SE in parentheses. continued

continued

Result from fitting the CAPM market model, 2005-2012

| | Constant | Beta | Milk Coef | P Value | # 0f Obs |
|---|---|---|---|---|---|
| Delegat Group Limited | 0.0032 | 0.3612 | 0.206 | 0.081094 | 84 |
| | (0.0096) | (0.2566) | (0.1259) | | |
| Downer EDI Limited Ord | -0.0009 | 0.5654 | 0.4752 | 0.825477 | 73 |
| | (0.0720) | (1.8099) | (0.9432) | | |
| Finzsoft Solutions Lim | -0.0171 | 0.0878 | 0.075 | 0.956879 | 81 |
| | (0.0222) | (0.5622) | (0.3188) | | |
| SmartFONZ | -0.0019 | 0.9062 | 0.0215 | 0.000000 | 94 |
| | (0.0024) | (0.0636) | (0.0335) | | |
| Green Cross Health Lim | -0.006 | 0.6733 | -0.367 | 0.070123 | 97 |
| | (0.0145) | (0.3921) | (0.2025) | | |
| Heartland Bank Limited | -0.0051 | 0.0879 | 0.108 | 0.390882 | 95 |
| | (0.0063) | (0.1701) | (0.0889) | | |
| Henderson Far East Ind | 0.0001 | 0.9976 | 0.3527 | 0.015467 | 73 |
| | (0.0162) | (0.4318) | (0.2024) | | |
| JPMorgan Japanese Indu | -0.0083 | 0.8257 | 0.3418 | 0.003888 | 97 |
| | (0.0121) | (0.3265) | (0.1686) | | |
| Kingfish Limited Ordin | 0.0009 | 0.3922 | -0.2091 | 0.359690 | 97 |
| | (0.0136) | (0.3672) | (0.1896) | | |
| Kathmandu Holdings Lim | 0.0011 | 1.2977 | 0.0862 | 0.136169 | 41 |
| | (0.0200) | (0.6523) | (0.2655) | | |
| Kircaldie & Stains | 0.0023 | 0.1781 | 0.1715 | 0.010278 | 97 |
| | (0.0047) | (0.1277) | (0.0659) | | |
| Millennium & Copthor | 0.0098 | 0.3281 | 0.1013 | 0.319347 | 97 |
| | (0.0098) | (0.2649) | (0.1368) | | |
| SmartMIDZ | -0.0018 | 0.8183 | 0.0307 | 0.000000 | 97 |
| | (0.0025) | (0.0685) | (0.0354) | | |
| Mercer Group Limited | -0.0104 | 0.1227 | -0.0798 | 0.941718 | 93 |
| | (0.0196) | (0.5198) | (0.2804) | | |
| Marlin Global Limited | -0.0039 | 0.1255 | -0.3457 | 0.457727 | 62 |
| | (0.0218) | (0.5491) | (0.2766) | | |
| Marsden Maritime Holdi | -0.0019 | 0.3729 | -0.0248 | 0.078033 | 97 |
| | (0.0060) | (0.1617) | (0.0835) | | |
| Methven Limited Ordina | -0.0006 | 0.9322 | 0.0947 | 0.000030 | 97 |
| | (0.0074) | (0.2015) | (0.1041) | | |
| Smart MOZY | -0.0015 | 1.1524 | -0.0638 | 0.000000 | 97 |
| | -0.0045 | -0.1228 | -0.0634 | | |
| NPT Limited Ordinary | 0.0079 | 0.5187 | 0.042 | 0.110044 | 51 |
| | (0.0079) | (0.2480) | (0.0947) | | |
| New Talisman Gold Mi | -0.0251 | 0.7365 | 0.2459 | 0.269840 | 97 |
| | (0.0210) | (0.5679) | (0.2933) | | |

@ SE in parentheses. continued

continued

Result from fitting the CAPM market model, 2005-2012

| | Constant | Beta | Milk Coef | P Value | # 0f Obs |
|---|---|---|---|---|---|
| New Zealand Oil & Gas | -0.002 | 0.779 | 0.0367 | 0.004380 | 97 |
| | (0.0086) | (0.2332) | (0.1204) | | |
| OceanaGold Corporation | -0.0191 | 2.2368 | 0.1352 | 0.102239 | 20 |
| | (0.0312) | (1.1905) | (0.6409) | | |
| Opus International Cor | 0.0026 | 1.0928 | 0.1959 | 0.000000 | 68 |
| | (0.0076) | (0.1979) | (0.0959) | | |
| SmartOZZY | 0.0027 | 0.9383 | -0.0592 | 0.000000 | 97 |
| | (0.0038) | (0.1030) | (0.0532) | | |
| Pacific Brands Limited | -0.0239 | 2.2837 | 0.2279 | 0.000031 | 93 |
| | (0.0185) | (0.4908) | (0.2570) | | |
| Pyne Gould Corporation | -0.0262 | 0.5368 | -0.2966 | 0.153792 | 97 |
| | (0.0139) | (0.3768) | (0.1946) | | |
| Wrightson Limited | -0.0164 | 0.8342 | 0.2275 | 0.007512 | 97 |
| | (0.0114) | (0.3086) | (0.1594) | | |
| Promisia Integrative | 0.0088 | 1.0528 | 0.1991 | 0.787249 | 83 |
| | -0.0656 | -1.7404 | -0.9578 | | |
| Pumpkin Patch Limited | -0.0107 | 1.3482 | 0.1428 | 0.000001 | 97 |
| | (0.0092) | (0.2484) | (0.1283) | | |
| Pan Pacific Petroleum | -0.0028 | 1.0888 | -0.4752 | 0.001658 | 97 |
| | (0.0133) | (0.3608) | (0.1863) | | |
| Rakon Limited Ordinary | -0.0321 | 1.3778 | 0.2556 | 0.000346 | 84 |
| | (0.0137) | (0.3640) | (0.1785) | | |
| Rubicon Limited Ordina | -0.0142 | 0.7454 | 0.1647 | 0.029304 | 97 |
| | (0.0115) | (0.3127) | (0.1615) | | |
| Scott Technology Limit | -0.0033 | 1.2052 | 0.068 | 0.000003 | 97 |
| | (0.0084) | (0.2262) | (0.1168) | | |
| Smiths City Group Limi | -0.0031 | 0.5048 | -0.0389 | 0.116411 | 97 |
| | (0.0088) | (0.2389) | (0.1234) | | |
| SeaDragon Limited Ordi | -0.0148 | 0.9552 | -0.4008 | 0.373015 | 95 |
| | (0.0306) | (0.8200) | (0.4239) | | |
| Seeka Kiwifruit Indust | -0.0165 | 0.5088 | -0.0864 | 0.254336 | 97 |
| | (0.0114) | (0.3094) | (0.1598) | | |
| Sealegs Corporation | -0.0183 | 1.8499 | 0.2722 | 0.000348 | 97 |
| | (0.0176) | (0.4768) | (0.2462) | | |
| South Port New Zealand | 0.0106 | 0.367 | 0.018 | 0.192439 | 97 |
| | (0.0075) | (0.2037) | (0.1052) | | |
| Smartpay Holdings Limi | -0.0167 | 0.4236 | -0.2994 | 0.597339 | 97 |
| | (0.0245) | (0.6627) | (0.3422) | | |
| The City of London Ind | -0.01 | 1.2908 | 0.168 | 0.364314 | 97 |
| | (0.0354) | (0.9591) | (0.4952) | | |

@ SE in parentheses. continued

continued

Result from fitting the CAPM market model, 2005-2012

| | Constant | Beta | Milk Coef | P Value | # 0f Obs |
|---|---|---|---|---|---|
| Templeton Emerging M | 0.0089 | 1.2657 | -0.0342 | 0.000000 | 97 |
| | (0.0059) | (0.1603) | (0.0828) | | |
| Tenon Limited Ordinary | -0.0106 | 1.0117 | 0.0302 | 0.012639 | 97 |
| | (0.0125) | (0.3373) | (0.1742) | | |
| T&G Global Limited Ord | -0.0049 | 0.4743 | 0.0371 | 0.070014 | 97 |
| | -0.0077 | -0.2089 | -0.1079 | | |
| Tourism Holdings Limit | -0.0158 | 1.8922 | 0.101 | 0.000000 | 97 |
| | (0.0082) | (0.2224) | (0.1149) | | |
| Trilogy International | 0.0042 | -0.8348 | -0.2647 | 0.243832 | 34 |
| | (0.0174) | (0.6421) | (0.2260) | | |
| Telstra Corporation | 0.0002 | 0.5658 | -0.0332 | 0.004376 | 97 |
| | (0.0061) | (0.1655) | (0.0855) | | |
| Trade Me Group Limited | 0.014 | 0.9451 | 0.0809 | 0.463166 | 13 |
| | (0.0321) | (1.0547) | (0.4931) | | |
| Turners Limited Ordina | -0.0272 | 2.1944 | -0.2227 | 0.008770 | 97 |
| | (0.0256) | (0.6919) | (0.3573) | | |
| SmartTENZ | -0.0039 | 0.9434 | -0.0049 | 0.000000 | 97 |
| | (0.0017) | (0.0452) | (0.0234) | | |
| TRS Investments Limite | -0.1634 | 1.2304 | -0.6355 | 0.840115 | 77 |
| | (0.0972) | (2.5103) | (1.4846) | | |
| TeamTalk Limited Ordin | 0.0071 | 0.5008 | -0.0593 | 0.004602 | 97 |
| | (0.0055) | (0.1481) | (0.0765) | | |
| Veritas Investments | -0.0188 | 1.2349 | -0.1461 | 0.632218 | 97 |
| | (0.0474) | (1.2843) | (0.6632) | | |
| VMob Group Limited Ord | -0.0221 | -1.1644 | -0.2994 | 0.273218 | 86 |
| | (0.0321) | (0.8271) | (0.4540) | | |
| Wellington Drive Techn | -0.0442 | 0.7903 | 0.217 | 0.108173 | 97 |
| | (0.0163) | (0.4406) | (0.2275) | | |
| Xero Limited Ordinary | 0.0298 | 0.8427 | -0.1483 | 0.043388 | 72 |
| | (0.0130) | (0.3444) | (0.1636) | | |

@ SE in parentheses.

# Appendix 5

## Result from fitting the CAPM market model,

## 2013-2016

Result from fitting the CAPM market model, 2013-2016

| | Constant | Beta | Milk Coef | P Value | # of Obs |
|---|---|---|---|---|---|
| Auckland Intl Airport | 0.0112 | 1.1041 | 0.0024 | 0.000007 | 40 |
| | (0.0057) | (0.1970) | (0.0447) | | |
| Air New Zealand | 0.01 | 1.3936 | -0.0024 | 0.006581 | 40 |
| | (0.0122) | (0.4222) | (0.0957) | | |
| ANZ Banking Group | -0.0159 | 1.1532 | 0.0227 | 0.003985 | 40 |
| | (0.0097) | (0.3377) | (0.0765) | | |
| Argosy Property | 0.0059 | 0.4475 | 0.0298 | 0.009503 | 40 |
| | (0.0045) | (0.1549) | (0.0351) | | |
| A2 Milk | 0.0208 | 0.9768 | 0.1433 | 0.333586 | 40 |
| | (0.0248) | (0.8615) | (0.1952) | | |
| Contact Energy | -0.0082 | 0.8885 | -0.1057 | 0.056920 | 40 |
| | (0.0110) | (0.3826) | (0.0867) | | |
| Coats Group | -0.0083 | 0.5977 | 0.0024 | 0.484383 | 40 |
| | (0.0146) | (0.5084) | (0.1152) | | |
| EBOS Group | 0.0235 | 0.2573 | 0.2113 | 0.013741 | 40 |
| | (0.0097) | (0.3357) | (0.0761) | | |
| Fletcher Building | -0.0176 | 1.5381 | -0.0017 | 0.000002 | 40 |
| | (0.0074) | (0.2583) | (0.0585) | | |
| Fisher & Paykel Hlthcr | 0.0317 | 0.378 | -0.014 | 0.524321 | 40 |
| | (0.0096) | (0.3342) | (0.0757) | | |
| Freightways | 0.0054 | 0.7251 | 0.028 | 0.023997 | 40 |
| | (0.0078) | (0.2716) | (0.0616) | | |
| Goodman Property Trust | 0.0058 | 0.5463 | 0.0533 | 0.002383 | 40 |
| | (0.0050) | (0.1727) | (0.0391) | | |
| Hellaby Holdings | 0.0007 | -0.021 | 0.0171 | 0.961448 | 40 |
| | (0.0079) | (0.2741) | (0.0621) | | |
| Hallenstein Glasson Hdg | -0.0153 | 0.7303 | -0.003 | 0.249196 | 40 |
| | (0.0127) | (0.4416) | (0.1001) | | |
| Infratil | 0.0026 | 0.7519 | -0.0871 | 0.022421 | 40 |
| | (0.0080) | (0.2765) | (0.0627) | | |
| Kiwi Property Group | 0.0052 | 0.4197 | 0.0205 | 0.123852 | 40 |
| | (0.0063) | (0.2183) | (0.0495) | | |
| Mainfreight | 0.0025 | 0.4984 | -0.0828 | 0.047265 | 40 |
| | (0.0065) | (0.2245) | (0.0509) | | |
| Metlifecare | -0.0016 | 1.1939 | -0.0594 | 0.007273 | 40 |
| | (0.0104) | (0.3603) | (0.0817) | | |
| Michael Hill Intl | -0.0104 | 0.8331 | 0.0912 | 0.011361 | 40 |
| | (0.0092) | (0.3204) | (0.0726) | | |
| Nuplex Industries | -0.001 | 1.4756 | -0.0793 | 0.003751 | 40 |
| | (0.0119) | (0.4146) | (0.0940) | | |

@ SE in parentheses.

continued

continued

Result from fitting the CAPM market model, 2013-2016

| | Constant | Beta | Milk Coef | P Value | # of Obs |
|---|---|---|---|---|---|
| NZX | -0.0017 | 0.2143 | -0.0115 | 0.650206 | 40 |
| | (0.0067) | (0.2329) | (0.0528) | | |
| New Zealand Refining | 0.0081 | 0.0618 | 0.0018 | 0.990393 | 40 |
| | (0.0136) | (0.4727) | (0.1071) | | |
| Precinct Properties NZ | 0.0088 | 0.1911 | 0.0291 | 0.382353 | 40 |
| | (0.0053) | (0.1827) | (0.0414) | | |
| Pacific Edge Ltd | -0.0251 | 2.4275 | -0.2238 | 0.093333 | 40 |
| | (0.0323) | (1.1210) | (0.2541) | | |
| Property For Industry | 0.0082 | 0.2612 | -0.0154 | 0.172276 | 40 |
| | (0.0040) | (0.1381) | (0.0313) | | |
| Port Of Tauranga | 0.0065 | 0.4621 | 0.0589 | 0.022784 | 40 |
| | (0.0058) | (0.2029) | (0.0460) | | |
| Restaurant Brands NZ | 0.0084 | 0.9024 | -0.0027 | 0.000818 | 40 |
| | (0.0064) | (0.2229) | (0.0505) | | |
| Ryman Healthcare | 0.0037 | 1.0673 | 0.0619 | 0.002050 | 40 |
| | (0.0089) | (0.3089) | (0.0700) | | |
| Sanford | 0.014 | -0.1299 | 0.0141 | 0.891979 | 40 |
| | (0.0083) | (0.2869) | (0.0650) | | |
| Sky City Entm Gp | -0.0058 | 1.2675 | 0.0128 | 0.000063 | 40 |
| | (0.0075) | (0.2616) | (0.0593) | | |
| Skellerup Holdings | -0.0002 | 0.3015 | 0.1214 | 0.162902 | 40 |
| | (0.0101) | (0.3490) | (0.0791) | | |
| Sky Network Television | -0.0118 | 1.2735 | 0.0501 | 0.001382 | 40 |
| | (0.0099) | (0.3452) | (0.0782) | | |
| Spark New Zealand | 0.0042 | 1.0195 | -0.0937 | 0.006233 | 40 |
| | (0.0089) | (0.3097) | (0.0702) | | |
| Steel And Tube Holdings | -0.0016 | 0.5708 | -0.06 | 0.329493 | 40 |
| | (0.0114) | (0.3975) | (0.0901) | | |
| Trustpower | -0.0032 | 0.4322 | -0.0536 | 0.117809 | 40 |
| | (0.0063) | (0.2192) | (0.0497) | | |
| Tower | -0.0056 | 0.2612 | -0.2128 | 0.197764 | 40 |
| | (0.0150) | (0.5192) | (0.1177) | | |
| Vector Ltd | 0.0105 | 0.0707 | 0.0353 | 0.703038 | 40 |
| | (0.0064) | (0.2230) | (0.0505) | | |
| Vital Healthcare Pr Tst | 0.0159 | 0.1493 | 0.0624 | 0.186926 | 40 |
| | (0.0053) | (0.1852) | (0.0420) | | |
| Westpac Banking Corp NZ | -0.0129 | 1.3357 | 0.0247 | 0.000279 | 40 |
| | (0.0089) | (0.3089) | (0.0700) | | |

@ SE in parentheses.

continued

continued

Result from fitting the CAPM market model, 2013-2016

| | Constant | Beta | Milk Coef | P Value | # of Obs |
|---|---|---|---|---|---|
| Warehouse Group | -0.0066 | 0.9039 | 0.009 | 0.022878 | 40 |
| | (0.0094) | (0.3247) | (0.0736) | | |
| Abano Healthcare Group | 0.0063 | 0.1433 | -0.0724 | 0.628574 | 40 |
| | (0.0100) | (0.3455) | (0.0783) | | |
| Australian Foundation | -0.0028 | 0.4302 | 0.0764 | 0.030344 | 40 |
| | (0.0063) | (0.2204) | (0.0500) | | |
| Allied Farmers Limited | -0.0214 | 2.594 | -0.2184 | 0.260762 | 40 |
| | (0.0461) | (1.6022) | (0.3631) | | |
| AMP Limited Ordinary | -0.0129 | 1.5066 | -0.0477 | 0.000739 | 40 |
| | (0.0105) | (0.3639) | (0.0825) | | |
| Aorere Resources Limit | -0.054 | 0.7266 | -0.0164 | 0.883441 | 40 |
| | (0.0427) | (1.4815) | (0.3357) | | |
| APN News & Media Limit | -0.0179 | 3.0862 | 0.0095 | 0.002070 | 40 |
| | (0.0240) | (0.8325) | (0.1887) | | |
| ASB Capital Limited | 0.0136 | -0.5699 | 0.0524 | 0.044654 | 40 |
| | (0.0066) | (0.2275) | (0.0516) | | |
| Augusta Capital Limite | 0.0107 | 0.1832 | -0.0383 | 0.636026 | 40 |
| | (0.0070) | (0.2424) | (0.0549) | | |
| AWF Madison Group Limi | 0.0001 | 0.461 | 0.1992 | 0.012912 | 40 |
| | (0.0101) | (0.3504) | (0.0794) | | |
| Briscoe Group Limited | 0.0108 | 0.2313 | 0.0488 | 0.370285 | 40 |
| | (0.0071) | (0.2480) | (0.0562) | | |
| Bethunes Investments | -0.0268 | 0.3373 | -0.0183 | 0.933955 | 40 |
| | (0.0266) | (0.9250) | (0.2096) | | |
| The Bankers Investment | -0.0036 | 0.8435 | 0.0059 | 0.000044 | 40 |
| | (0.0049) | (0.1694) | (0.0384) | | |
| BLIS Technologies Limi | 0.0152 | 0.3014 | -0.1997 | 0.779747 | 40 |
| | (0.0368) | (1.2773) | (0.2895) | | |
| Barramundi Limited O | -0.0002 | 0.0204 | 0.0519 | 0.483725 | 40 |
| | (0.0057) | (0.1979) | (0.0448) | | |
| Cavalier Corporation | -0.0317 | 0.8485 | 0.0564 | 0.540963 | 40 |
| | (0.0246) | (0.8549) | (0.1938) | | |
| CDL Investments New | 0.0154 | -0.2041 | 0.0336 | 0.721942 | 40 |
| | (0.0084) | (0.2912) | (0.0660) | | |
| The Colonial Motor Cor | 0.0038 | 1.1325 | -0.0562 | 0.000080 | 40 |
| | (0.0067) | (0.2314) | (0.0524) | | |
| Chorus Limited (NS) | -0.02 | 2.2451 | -0.28 | 0.002996 | 40 |
| | (0.0189) | (0.6570) | (0.1489) | | |
| Comvita Limited Ordina | 0.037 | -0.4398 | -0.0302 | 0.598662 | 40 |
| | (0.0140) | (0.4874) | (0.1105) | | |
| Cleanaway Waste Manage | -0.044 | 3.6222 | 0.8553 | 0.064444 | 40 |
| | (0.0695) | (2.4126) | (0.5468) | | |

Continued

@ SE in parentheses.

continued

Result from fitting the CAPM market model, 2013-2016

| | Constant | Beta | Milk Coef | P Value | # of Obs |
|---|---|---|---|---|---|
| Delegat Group Limited | 0.017 | 0.2019 | 0.0176 | 0.774025 | 40 |
| | (0.0095) | (0.3289) | (0.0745) | | |
| Downer EDI Limited Ord | 0.0036 | -0.0257 | -0.01 | 0.572946 | 40 |
| | (0.0015) | (0.0533) | (0.0121) | | |
| Finzsoft Solutions Lim | 0.0332 | 0.8275 | -0.2809 | 0.606613 | 40 |
| | (0.0400) | (1.3904) | (0.3151) | | |
| SmartFONZ | 0.0014 | 0.8565 | 0.014 | 0.000000 | 40 |
| | (0.0021) | (0.0715) | (0.0162) | | |
| Fonterra Shareholder | -0.0076 | 0.5265 | 0.0144 | 0.182383 | 40 |
| | (0.0085) | (0.2958) | (0.0670) | | |
| Green Cross Health Lim | 0.0226 | 0.3021 | 0.0951 | 0.402655 | 40 |
| | (0.0122) | (0.4228) | (0.0958) | | |
| Heartland Bank Limited | 0.0107 | 0.782 | 0.0566 | 0.013879 | 40 |
| | -0.0083 | -0.2869 | -0.065 | | |
| Henderson Far East Ind | -0.0028 | 0.4552 | -0.0535 | 0.319896 | 31 |
| | (0.0080) | (0.3329) | (0.0657) | | |
| JPMorgan Japanese Indu | -0.035 | 1.9145 | 0.2995 | 0.231736 | 25 |
| | (0.0390) | (1.5446) | (0.2900) | | |
| Kingfish Limited Ordin | 0.0067 | 0.2074 | 0.0445 | 0.068739 | 40 |
| | (0.0038) | (0.1335) | (0.0303) | | |
| Kathmandu Holdings Lim | -0.0029 | 0.2318 | -0.0638 | 0.903971 | 40 |
| | (0.0218) | (0.7561) | (0.1714) | | |
| Kircaldie & Stains | 0.0039 | -0.2933 | -0.061 | 0.740552 | 40 |
| | (0.0165) | (0.5736) | (0.1300) | | |
| Millennium & Copthor | 0.0333 | -0.0058 | -0.0291 | 0.982691 | 40 |
| | (0.0206) | (0.7138) | (0.1618) | | |
| SmartMIDZ | 0.005 | 0.7483 | -0.0184 | 0.000000 | 40 |
| | (0.0029) | (0.1007) | (0.0228) | | |
| Mercer Group Limited | -0.0341 | -1.1513 | -0.1392 | 0.536481 | 40 |
| | (0.0370) | (1.2829) | (0.2908) | | |
| Marlin Global Limited | 0.0068 | -0.0964 | 0.0513 | 0.552187 | 40 |
| | (0.0062) | (0.2151) | (0.0487) | | |
| Marsden Maritime Holdi | 0.0065 | 0.3547 | 0.0885 | 0.043755 | 40 |
| | (0.0065) | (0.2264) | (0.0513) | | |
| Methven Limited Ordina | 0.0002 | 0.3469 | -0.0653 | 0.608771 | 40 |
| | (0.0121) | (0.4194) | (0.0951) | | |
| Smart MOZY | -0.0035 | 0.6799 | -0.0695 | 0.009430 | 40 |
| | (0.0063) | (0.2192) | (0.0497) | | |
| NPT Limited Ordinary | 0.007 | 0.1394 | 0.014 | 0.741057 | 40 |
| | (0.0062) | (0.2154) | (0.0488) | | |
| New Talisman Gold Mi | -0.0198 | 0.88 | -0.2698 | 0.561198 | 40 |
| | (0.0368) | (1.2788) | (0.2898) | | |

@ SE in parentheses.

continued

continued

Result from fitting the CAPM market model, 2013-2016

| | Constant | Beta | Milk Coef | P Value | # of Obs |
|---|---|---|---|---|---|
| New Zealand Oil & Gas | -0.0193 | 0.5804 | -0.0914 | 0.116799 | 40 |
| | (0.0089) | (0.3106) | (0.0704) | | |
| OceanaGold Corporation | 0.007 | -0.0335 | -0.1486 | 0.853391 | 40 |
| | (0.0349) | (1.2102) | (0.2743) | | |
| Opus International Cor | -0.0088 | 0.3293 | -0.0442 | 0.478065 | 40 |
| | (0.0085) | (0.2944) | (0.0667) | | |
| SmartOZZY | -0.0083 | 0.724 | -0.0248 | 0.004702 | 40 |
| | (0.0060) | (0.2081) | (0.0472) | | |
| Pacific Brands Limited | 0.0225 | -0.7384 | -0.0766 | 0.459396 | 40 |
| | (0.0204) | (0.7087) | (0.1606) | | |
| Pyne Gould Corporation | -0.0035 | 0.1534 | -0.1364 | 0.566422 | 40 |
| | (0.0164) | (0.5691) | (0.1290) | | |
| Wrightson Limited | -0.0079 | 1.1379 | -0.1783 | 0.051188 | 40 |
| | (0.0147) | (0.5109) | (0.1158) | | |
| Promisia Integrative | 0.0309 | -1.9236 | 0.4066 | 0.128489 | 40 |
| | (0.0339) | (1.1759) | (0.2665) | | |
| Pumpkin Patch Limited | -0.0841 | 1.1018 | -0.0231 | 0.516816 | 40 |
| | (0.0279) | (0.9670) | (0.2192) | | |
| Pan Pacific Petroleum | -0.0474 | 1.0185 | 0.0005 | 0.482827 | 40 |
| | (0.0248) | (0.8617) | (0.1953) | | |
| Rakon Limited Ordinary | -0.0445 | 2.6076 | -0.3421 | 0.003761 | 40 |
| | (0.0227) | (0.7886) | (0.1787) | | |
| Rubicon Limited Ordina | -0.0182 | 1.0774 | -0.1377 | 0.149181 | 40 |
| | (0.0168) | (0.5846) | (0.1325) | | |
| Scott Technology Limit | -0.0162 | 0.9131 | 0.0696 | 0.066903 | 40 |
| | (0.0125) | (0.4337) | (0.0983) | | |
| Smiths City Group Limi | 0.0029 | -0.1912 | -0.1331 | 0.059311 | 40 |
| | (0.0078) | (0.2713) | (0.0615) | | |
| SeaDragon Limited Ordi | -0.0168 | 0.1642 | 0.0681 | 0.930871 | 40 |
| | (0.0288) | (1.0004) | (0.2267) | | |
| Seeka Kiwifruit Indust | 0.0457 | -0.183 | -0.0242 | 0.922517 | 40 |
| | (0.0169) | (0.5852) | (0.1326) | | |
| Sealegs Corporation | -0.0036 | -0.2857 | 0.2924 | 0.450916 | 40 |
| | (0.0295) | (1.0253) | (0.2324) | | |
| South Port New Zealand | 0.0173 | -0.1372 | -0.0027 | 0.889209 | 40 |
| | (0.0086) | (0.2969) | (0.0673) | | |
| Smartpay Holdings Limi | -0.0228 | 0.7731 | 0.024 | 0.587305 | 40 |
| | (0.0228) | (0.7929) | (0.1797) | | |
| The City of London Ind | -0.0431 | 3.9239 | -0.1463 | 0.385258 | 40 |
| | (0.0818) | (2.8417) | (0.6440) | | |

@ SE in parentheses.

continued

continued

Result from fitting the CAPM market model, 2013-2016

| | Constant | Beta | Milk Coef | P Value | # of Obs |
|---|---|---|---|---|---|
| Templeton Emerging M | -0.02 | 0.954 | -0.099 | 0.011100 | 40 |
| | (0.0091) | (0.3143) | (0.0712) | | |
| Tenon Limited Ordinary | 0.0226 | 0.4554 | -0.0711 | 0.590407 | 40 |
| | (0.0144) | (0.5017) | (0.1137) | | |
| T&G Global Limited Ord | 0.0094 | 0.076 | 0.0279 | 0.818082 | 40 |
| | (0.0073) | (0.2534) | (0.0574) | | |
| Tourism Holdings Limit | 0.0349 | 0.3461 | -0.1032 | 0.410521 | 40 |
| | (0.0114) | (0.3959) | (0.0897) | | |
| Trilogy International | 0.0355 | -0.3873 | -0.0437 | 0.882163 | 40 |
| | (0.0274) | (0.9522) | (0.2158) | | |
| Telstra Corporation | 0.0004 | 0.4718 | -0.0392 | 0.274815 | 40 |
| | (0.0086) | (0.2972) | (0.0673) | | |
| Trade Me Group Limited | -0.0013 | 0.6585 | -0.0468 | 0.180237 | 40 |
| | (0.0102) | (0.3551) | (0.0805) | | |
| Turners Limited Ordina | 0.0378 | 1.3028 | -0.2667 | 0.772214 | 40 |
| | (0.0653) | (2.2668) | (0.5137) | | |
| SmartTENZ | 0.0002 | 0.8488 | 0.0262 | 0.000000 | 40 |
| | (0.0019) | (0.0669) | (0.0152) | | |
| TRS Investments Limite | -0.0646 | 7.2263 | -0.2195 | 0.015457 | 40 |
| | (0.0690) | (2.3968) | (0.5432) | | |
| TeamTalk Limited Ordin | -0.038 | 1.0312 | -0.0841 | 0.399632 | 40 |
| | (0.0223) | (0.7739) | (0.1754) | | |
| Veritas Investments | -0.0625 | 0.8957 | -0.3068 | 0.099633 | 40 |
| | (0.0198) | (0.6880) | (0.1559) | | |
| VMob Group Limited Ord | -0.0165 | 0.4124 | -0.7126 | 0.809483 | 40 |
| | (0.1409) | (4.8925) | (1.1088) | | |
| Wellington Drive Techn | -0.0067 | -0.3012 | -0.0237 | 0.954401 | 40 |
| | (0.0327) | (1.1345) | (0.2571) | | |
| Xero Limited Ordinary | 0.0008 | 1.8664 | 0.522 | 0.005400 | 40 |
| | (0.0275) | (0.9555) | (0.2165) | | |

@ SE in parentheses.